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(54) Laser marking machine.

(57) An articulatable robotic machine has a forearm (21) and wrist unit (19) capable of handling an internal laser beam (23) received at the aft end (21a) of the forearm and exiting at the forward end (21b) of the forearm through the wrist unit tooling plate (22). A laser marker galvohead (14) and collimator (13) are affixed to the tooling plate of the wrist, and a laser generator (12) is affixed to the forearm (21) of the robot machine and provided with a laser beam system to direct a laser beam (23) into the aft end of the laser arm. The output pattern galvohead may be manipulated to a variety of predetermined positions on a workpiece (33).

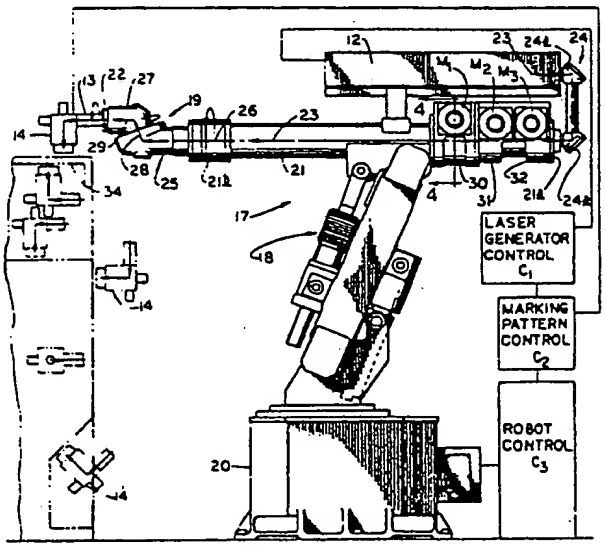

FIG.2

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"Laser Marking Machine"

The invention relates generally to laser marking machines, and is particularly directed to multi-station applications through the use of a robotic machine.

Laser marking machines have been utilised for a number of years for marking a variety of workpieces, and these machines are particularly effective where it is desired to mark very hard surfaces. Laser marking machines are also highly desirable since an investment does not have to be made in hard tooling, and the pattern, therefor, can be changed frequently at minimal cost without the need for scrapping or revising tooling.

Laser marking machines have been used in the automotive field for marking certain components and body parts, and in the future the automotive industry will be required to mark more parts and different locations on an automobile body.

One drawback to prior art laser marking machines is that the entire machine i.e. laser control unit, laser collimator and marking head, or "galvohead", are fixed at one particular location with the laser pattern output directed to one fixed marking point.

Applicant has obviated the difficulties inherent in the prior art laser marking machines by the utilisation of an articulatable robotic machine, which is capable of handling a laser beam internally, thereby presenting a compact assembly which can be manoeuvered in and about an automobile body, for instance, for marking a plurality of positions, in a variety of attitudes.

According to this invention there is provided a laser marking machine comprising movable forearm having a forward end and an aft end, and an internal forearm beam path connecting said forward and aft ends, a laser beam source means connected to said aft end of said forearm for providing a laser beam travelling along said beam path from said aft end to said forward end, laser wrist means carried at said forward end of said forearm for receiving and manipulating said beam, said wrist means including a tooling plate and means for moving said tooling plate with respect to said forearm, a laser marking head affixed to said tooling plate, said marking head including galvohead means for moving said laser beam through a predetermined output pattern with respect to said tooling plate, first control means for moving said tooling plate through prdetermined spatial movements, and second control means for driving said galvohead means.

Preferably the laser beam source means includes a laser generator carried on said forearm and a laser beam conductor connecting said generator to said aft end of said forearm.

Preferably the laser generator has an exit path parallel to said forearm beam path, and the beam travels said exit path in a direction generally towards said aft end of said forearm, the laser beam conductor including means for reversing the beam travel direction from said exit path into said forearm.

According to this invention there is also provided a laser marking machine comprising a marking head, a laser generator to deliver a laser beam to said marking head, the marking head comprising galvohead means for moving the laser beam delivered thereto through a desired output pattern, control means for controlling the laser generator and control means for controlling the galvohead means, characterised in that the marking head is carried on the end effector on the forward end of a robotic forearm, control means being provided for moving the forearm and for moving the end effector relative to the forearm, and in that the laser generator is connected to the aft end of the robotic forearm.

Preferably the laser generator is mounted on the forearm, and is advantageously operative to produce a laser beam directed rearwardly parallel to the longitudinal axis of the forearm, means being provided to reverse the beam into the forearm from the aft end towards the forward end along said axis.

The invention is shown embodied in a laser marking machine, wherein a laser forearm is movable on the robotic structure and has an internal beam path connecting forward and aft ends of the movable forearm. A laser beam source is connected to the aft end of the forearm and provides a laser beam through the forearm. A laser wrist is carried at the forward end of the forearm for receiving and manipulating an internally-carried laser beam, wherein the wrist carries an end effector or tooling plate and has means for automatically moving the tooling plate with respect to the forearm. A laser marker head, or galvohead, is affixed to the tooling plate, the head including conventional galvohead means (e.g. movable mirrors) for moving the laser beam delivered to the galvohead through a predetermined output pattern with respect to the tooling plate. First control means is provided for moving the tooling plate through a predetermined spatial orientations; a second control means is provided for driving the galvohead means to produce the output pattern; and third control means actuates the laser beam source.

There will now be given a detailed description, to be read with reference to the accompanying drawings, of a laser marking machine which is the preferred embodiment of this invention, having been selected for the purposes of illustrating the invention by way of example.

In the accompanying drawings:

FIGURE 1 is a side elevational view of a prior art, fixed station laser marking machine;

FIGURE 2 is a side elevational view of the laser marking machine which is the preferred embodiment of this invention;

FIGURE 3a is a side elevational section through the aft end of the forearm unit of the marking machine of Figure 2;

FIGURE 3b is a side elevational section through the wrist unit and forward end of the forearm unit of the marking machine of Fiugre 2; and

FIGURE 4 is a section through a typical wrist drive motor taken along the line 4-4 of Figure 2.

Figure 1 of the drawings depicts a prior art, fixed-station laser marking machine 10, wherein a station base 11 is provided, and on which is mounted a laser generator unit 12, having a laser beam collimator 13 attached to its output end, in turn supporting a laser marking head, or galvohead 14. A laser generator control C1 is provided to control the laser output, and a marker pattern control C2 is provided to control the galvohead 14, so that the laser beam 15 will produce a predetermined marking pattern on a target surface 16. Typical patterns might be used to mark part numbers, or to produce Designs, Trade Marks, etc. The galvohead 14 is capable of a high response rate in directing the beam 15 through a pattern.

In the robotic marking machine which is the preferred embodiment of this invention depicted in Figure 2, the laser generator unit 12 is separated from the galvohead 14 and collimator 13. A unique articulatable laser robot 18 is depicted, and is capable of moving a wrist unit 19 through a variety of mutli-spatial orientations with respect to the robotic base 20. The laser robot 18 is the subject of copending USA Patent Application Serial No. 840,637 (EPA No: 0238308) the disclosure of which is incorporated by reference herein. Reference may also be had to USA Patent 4626999 (Application Serial No. 601784) depicting a laser generator mounted end-for-end the reverse of the present design.

The laser generator unit 12 is mounted proximal to the aft end 21a of the robotic forearm 21, and the galvohead 14 is affixed to a tooling plate 22 at the wrist unit 19 on the forward end 21b of the forearm 21. The laser generator unit 12 produces an output laser beam 23 having an exit path directed generally towards the aft end 21 a and which is ducted through a light pipe system 24 including a pair of 90° mirror units 24a and into the aft end 21a of the forearm 21, wherein the beam 23 travels internally through the forearm 21 and wrist unit 19, subsequently exiting through the collimator and galvohead 14.

The wrist unit 19 comprises a base housing 25 which is mounted for movement about a first roll axis 26 of the forearm 21, and the base housing 25 supports a turret housing 27, which is power-driven around a second roll axis 28 intercepting the first roll axis 26. The turret housing 27 carries the rotatable tooling plate 22 which is free to rotate about a third roll axis 29, intersecting the second roll axis 28, said roll axes 26, 28 and 29 defining a laser beam path. Thus, "three-roll" movement may be employed, fully manipulating the galvohead 14 and laser beam 23. The wrist unit 19 is power-driven by three motors M1, M2, and M3, which are remotely located on suitable gear boxes 30, 31, 32 at the aft end 21a of the forearm 21.

A robotic control C3 is employed, and is coordinated with the laser control C1 and the marking pattern control C2. While the units have been depicted as separate, it will be appreciated that they may be embodied within a common control console. Thus, in use, the galvohead is positioned in relation to a workpiece by the robotic control C3, and the galvohead means is controlled by the control means C2 (whilst the control C1 controls generation of the laser beam) to produce the required marking of the part. A typical workpiece 33 is depicted in phantom, at which the galvohead 14 is shown oriented to a variety of spatial positions, to mark the various surfaces. The galvohead 14 may be also transported within a cavity 34 of the workpiece 33 and such a workpiece 33 might comprise an automobile body, for example.

Referring the Figures 3a i.e. a section through the forearm 21, a plurality of concentric drive tubes, T1, T2, and T3 are provided with worm wheels 35, 36, 37, which are driven respectively by worms 38, 39, 40 connected to the respective drive motors, M1, M2 and M3 (see Figure 4). The laser beam 23 is received from the closed light pipe system 24 through the 90° mirror unit 24 a at the cap 41 at the rear of the unit. Complete sealing is provided on the T1, T2, T3 tubes, so that the beam path will remain clear of contamination. Referring to the continuation of the unit at Fiugre 3b , a simplified digrammatic view of the wrist unit 19 of Figure 2 is depicted, and as stated above, the three-concentric drive tubes T1, T2 and T3 are driven by respective drive motors M1, M2 and M3 in the non-rotating forearm 21. The simplified structure shows that the drive tube T1 provides the roll 1 movement i.e., complete wrist rotation around the roll 1 axis 26. A bevel gear G1 on drive tube T2 serves to provide the rotational movement to the turret hous-

ing 27, around the roll 2 axis 28, since gears G1 and G2 (on the turret housing 27) are in mesh. In order to provide rotary movement of the tooling plate 22, the innermost drive tube T3 has a bevel gear G3 located at its inboard end, in mesh with the gear G4 of a rotary spindle 42 supported in the turret housing 27. The spindle 42 also has a gear G5 at its opposite end, in mesh with the gear G6 of the tooling plate spindle 43 so that the tooling plate 22 will rotate around the roll 3 axis 29. Mirrors 44, 45 are supported as shown, within the respective turret housing 27 and base housing 25. Here it may be appreciated that while fixed mirror assemblies are depictred, the units may be provided with adjustable mounts, as are fully depicted in said copending Application, Serial No. 840,637. The sealing tubes 46, 47 and 48 are sealed at seal points A, B and C, to provide a closed path for the laser beam 23.

The laser collimator of Figures 1 and 2 is shown affixed to the tooling plate 22, and is therefore movable through a wide variety of multi-spatial orientation with respect to the robotic base 20.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, or a class or group of substances or compositions, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Claims

1. A laser marking machine comprising a movable forearm (21) having a forward end (21b) and an aft end (21a), an internal forearm beam path (26) connecting said forward and aft ends; a laser beam source means (12, 24) connected to said aft end (21a) of the forearm for providing a laser beam (23) travelling along said beam path from said aft end to said forward end; laser wrist means (19) carried at said forward end (21b) of the forearm (21) for receiving and manipulating said beam (23), said wrist means including a tooling plate (22) and means (M1, M2, M3) for moving said tooling plate with respect to said forearm; a laser marker head (14) affixed to said tooling plate, said marking head (14) including galvohead means for moving said laser beam through a predetermined output pattern with respect to said tooling plate; first control means (C3) for moving said tooling plate through predetermined spatial movements; and second control means (C2) for driving said galvohead means.

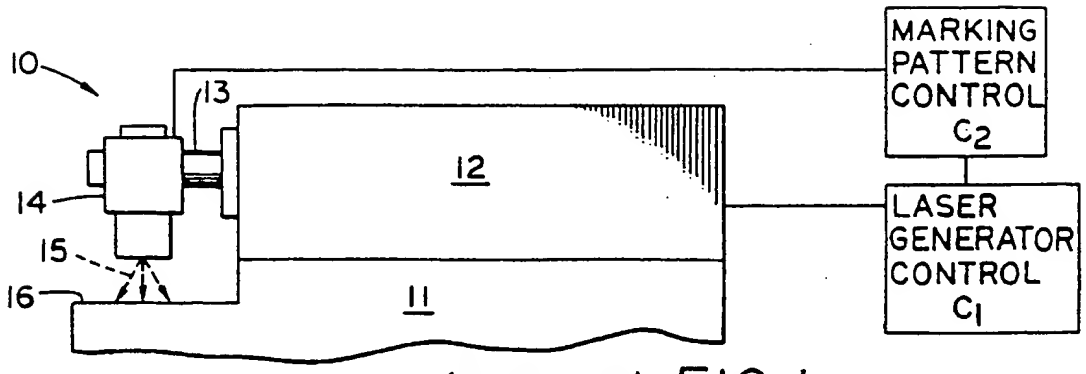
2. A machine according to Claim 1 wherein said laser beam source means includes a laser generator (12) carried on said forearm (21), and a laser beam conductor (24) connecting said generator (12) to said aft end (21a) of the forearm.

3. A machine according to one of Claims 1 and 2 wherein said laser generator (12) has an exit path parallel to said forearm beam path, and wherein said beam travels said exit path in a direction generally toward said aft end (21a) of said forearm, and wherein said laser beam conductor includes means (24 a, 24b) for reversing the beam travel direction from said exit path, into said forearm.

4. A laser marking machine comprising a marking head (14), a laser generator (12) to deliver a laser beam to the marking head, the marking head comprising galvohead means for moving the laser beam delivered thereto through a desired output pattern, control means (C1) for controlling the laser generator and control means (C2) for controlling the galvohead means, characterised in that the marking head (14) is carried on the end effector (22) on the forward end (21 b) of a robotic forearm (21), control means (C3) being provided for moving the forearm (21) and for moving the end effector (22) relative to the forearm, and in that the laser generator (12) is connected to the aft end (21a) of the robotic forearm (21).

5. A machine according to Claim 4 wherein the laser generator (12) is mounted on the forearm (21).

6. A machine according to one of Claims 4 and 5 wherein the laser generator is operative to produce a laser beam (23)directed rearwardly parallel to a longitudinal axis of the forearm (21), means (24a, 24b) being provided to reverse the beam into the forearm (21) from the aft end (21a) towards the forward end (21b) along said axis.



(PRIOR ART) FIG. 1

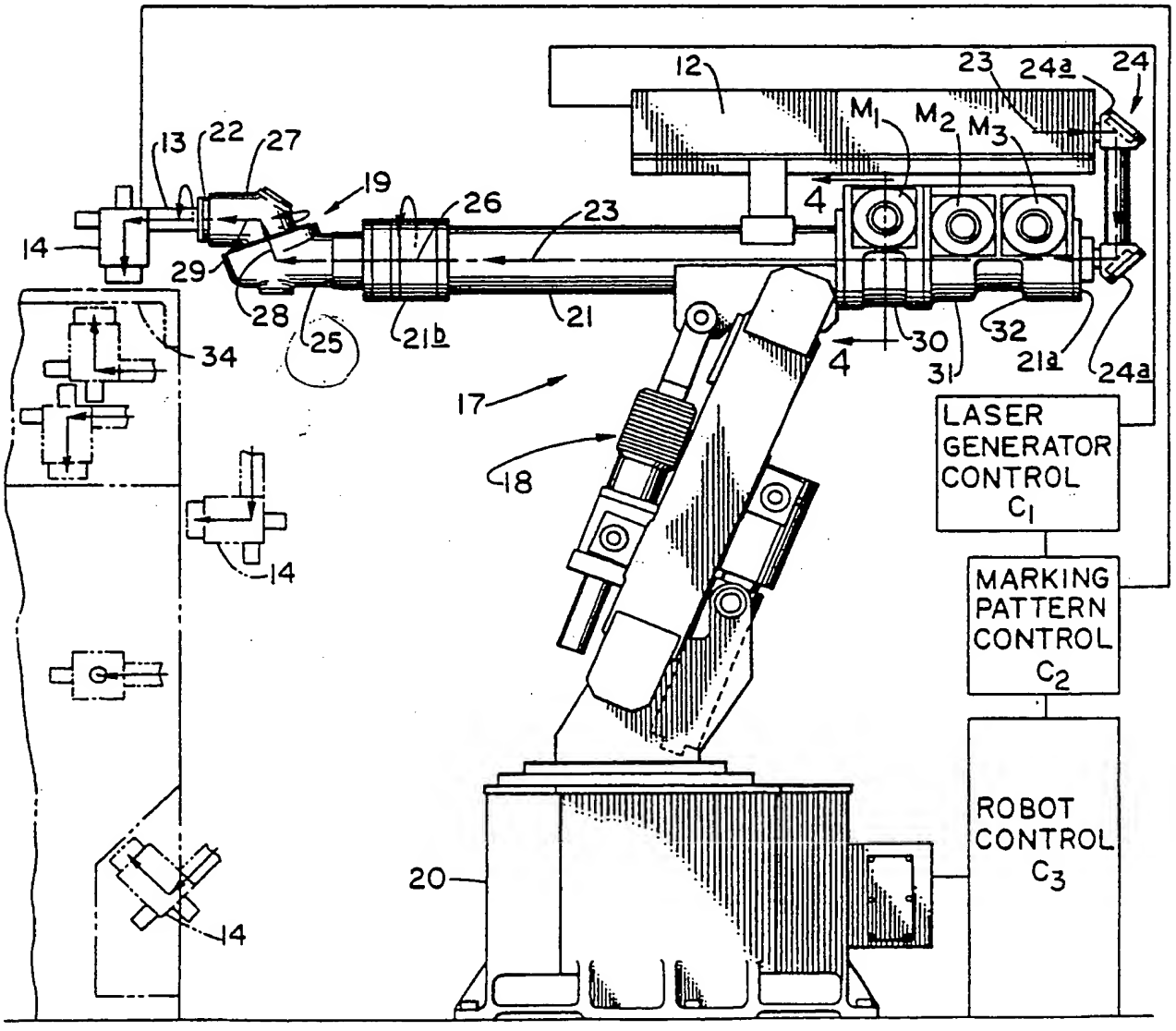


FIG. 2

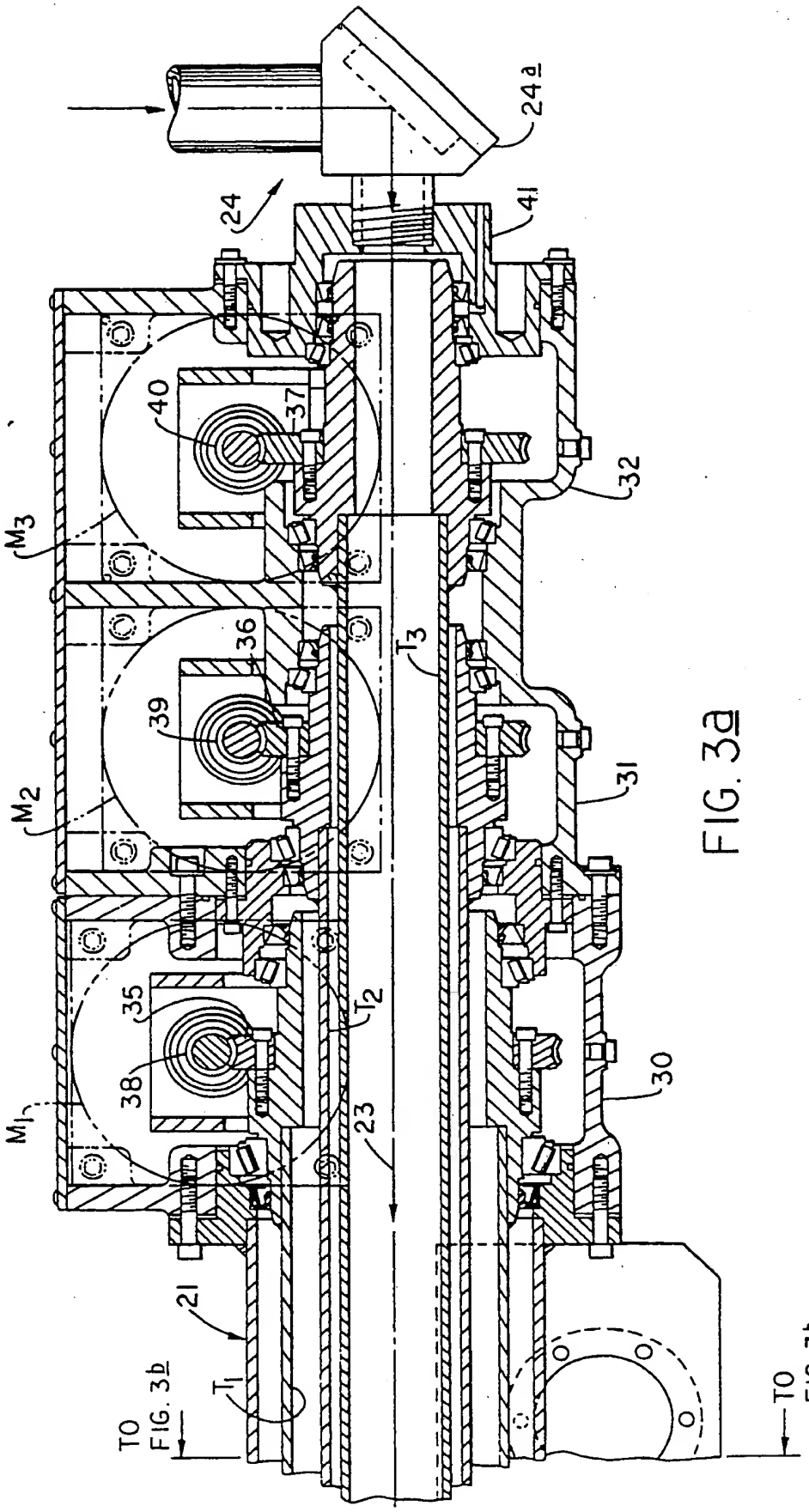

24a
24
41
40
37
32
M3
36
T3
39
31
M2
35
T2
38
30
M1
23
21
T1
TO FIG. 3b
TO FIG. 3b

FIG. 3a

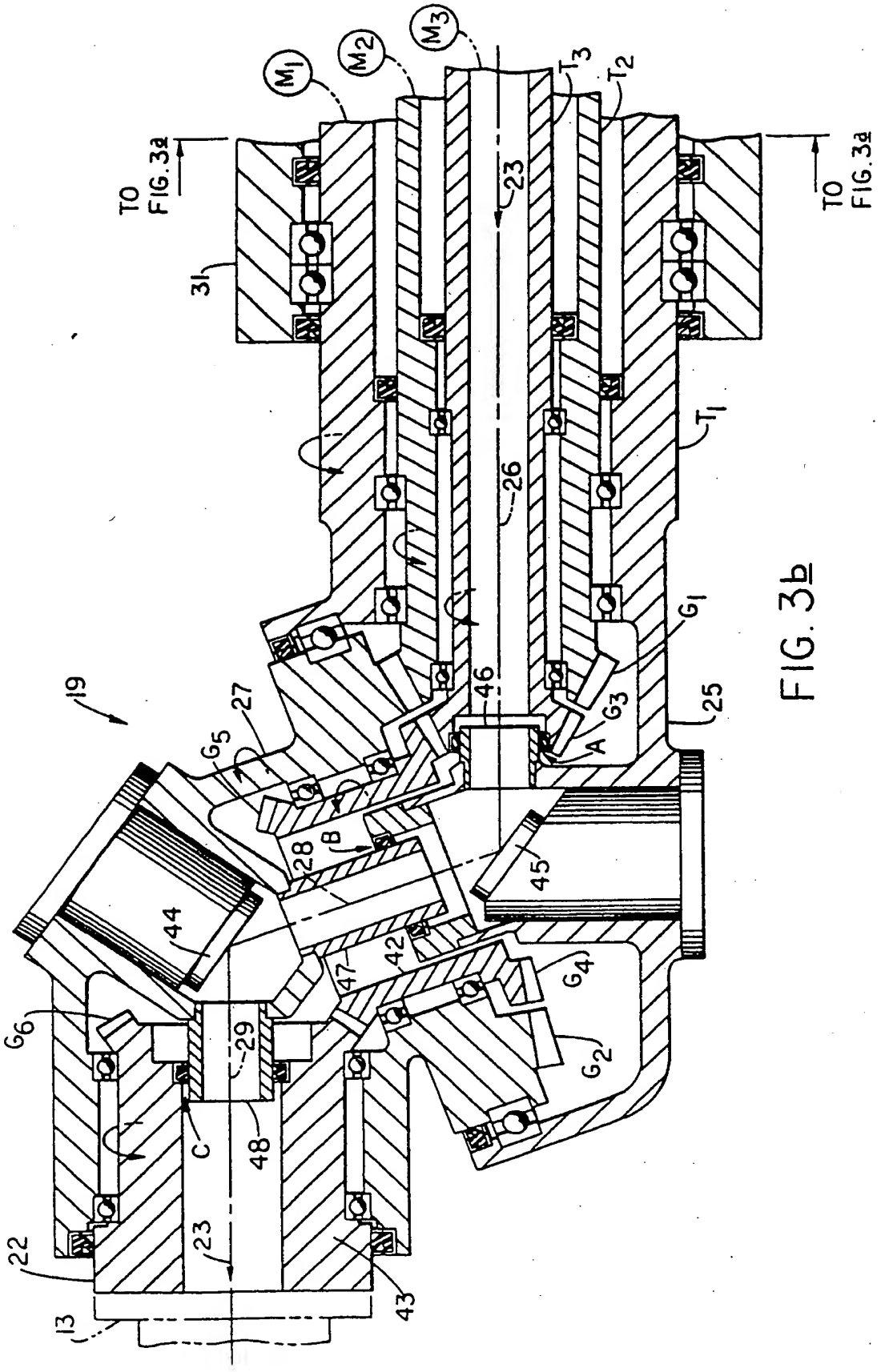

M1
M2
M3
T3
T2
T1
TO FIG.3a
TO FIG.3a
31
23
26
46
25
19
27
G5
G1
G3
A
B
28
45
44
42
47
G4
G6
G2
29
C
48
22
23
43
13

FIG. 3b

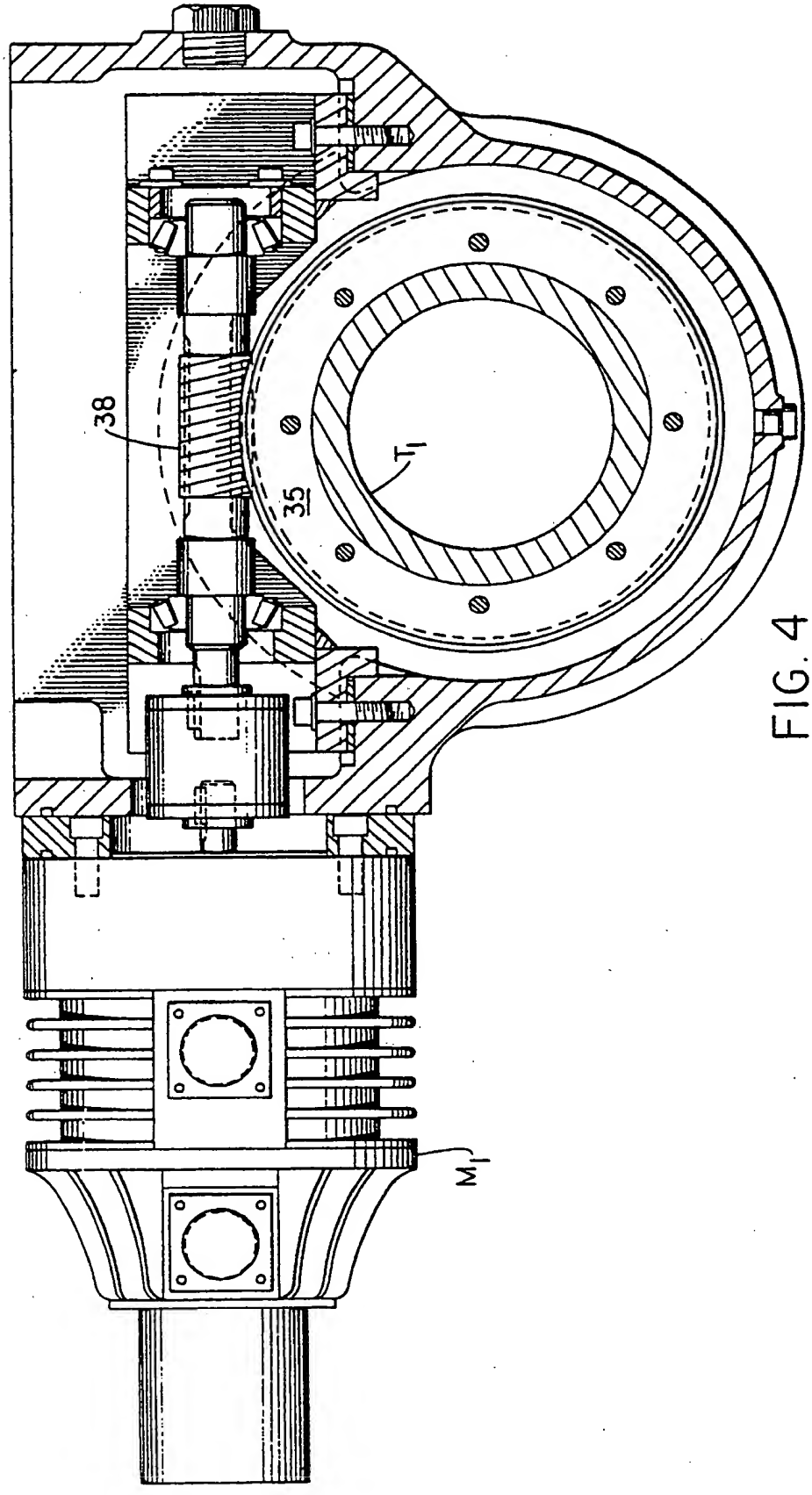


FIG. 4

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EUROPEAN SEARCH REPORT

Application Number

EP 87 11 3776

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
P,X	US-A-4 661 681 (BANNISTER) * Whole document *	1-6	B 23 K 26/10 B 25 J 19/00 B 44 B 7/00
A	EP-A-0 160 293 (CINCINNATI MILACRON LTD) * Page 12, lines 19-25 *	1	
A	EP-A-0 096 630 (COMMISSARIAT A L'ENERGIE ATOMIQUE) * Page 7, line 14 - page 8, line 17 *	1	
A	GB-A-2 059 354 (RCA CORP.) * Page 3, lines 75-112 *	1,4	
A	FR-A-2 337 538 (MOCHIDA PHARMACEUTICAL CO. LTD)		
A	EP-A-0 178 011 (BISIACH & CARRU S.p.A.)		
P,A	US-A-4 626 999 (BANNISTER)		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)
B 25 J B 23 K B 44 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11-01-1988	LAMMINEUR P.C.G.

CATEGORY OF CITED DOCUMENTS

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